New Department Handles British Technical Aid Overseas

The work of the recently-created Department of Technical Co-operation is now in full swing. The Minister in charge, Mr. Dennis Vosper, has appointed a committee of experts to advise him on how best to provide the developing countries with technical assistance from Britain, in agriculture, animal health, forestry and fisheries.

The Department came into being at the end of July when it became responsible for co-ordinating United Kingdom technical assistance to developing countries. It has taken over all advisers from the Colonial Office and Commonwealth Relations Office who previously handled technical aid.

The new Department is a reflection of what the Prime Minister, Mr. Harold Macmillan, has described as 'the growth in size and importance' of Britain's plans for underdeveloped countries.

Among the main activities of the new Department are:

(1) The recruitment of staff for service with overseas governments and international organizations.

(2) Arranging the training of such staff, including people already in the service of overseas governments.

(3) Administration of the Overseas Service Aid Scheme designed to help certain governments to retain the services of overseas officials till local public services can be firmly established.

(4) Responsibility for the work of the Directorate of Overseas Geodetic and Topographic Surveys and of the Directorate of Overseas Geological Surveys.

(5) Dealing with aspects of Commonwealth educational co-operation affecting the United Kingdom.

(6) Handling special technical assistance projects overseas undertaken at the request of the governments concerned.

(7) Handling requests from the U.K. dependent territories for technical assistance (including financing of such assistance) under Colonial Development and Welfare Acts, and from Commonwealth and foreign countries and international agencies.

(8) Making arrangements for assistance in the field of research, principally on the subjects of importance to the dependent territories or where the U.K. has a special contribution to make overseas.

(9) Supplementing the work of other organizations in placing overseas students in the U.K.

(10) Assistance to overseas governments on technical matters relating to air and surface transport, telecommunications and postal services.

(11) Provision to overseas governments, at their request, of specialist advice on a wide variety of subjects such as agriculture, education, fisheries, and medicine.

In a recent speech, Mr. Vosper said that the Department was widening its horizon. 'When a country becomes independent', declared the Minister, 'it is inclined to ignore research. That is where we can help . . . We will take over where colonial development and welfare have to leave off when the country becomes independent'.

News Round-up

Open Days at Tropical Products Institute

The Tropical Products Institute opened its doors to members of the public for the first time in mid-October and, for two days, visitors—including many from the Commonwealth—were able to see some of the work being carried out in its 20 laboratories.

The Institute's main aim is to assist less developed countries of the tropics and subtropics to extend the development and use of their resources of plant or animal origin and the industries based on them. A number of Commonwealth students have passed through the laboratories for training either on technical assistance scholarships or during their vacations from U.K. universities.

One line of major research being undertaken concerns new uses for sugar, supplies of which considerably exceed consumption. If the research succeeds, it could lead to a whole range of new industrial uses for sugar, particularly in the manufacture of detergents.

Scientists at the Institute are also investigating the strength properties of a new hybrid sisal plant, developed by the Tanganyika Sisal Growers Association over a number of years. Tests have shown that for the first six cuts—leaves are cut at six-monthly intervals—the hybrid fibre is finer than normal sisal, its breaking strength lower, and its tensile strength the same.

Groundnut shells and rice husks which were previously wasted can be made into building boards and even into paper. Coffee tables made from groundnut chipboard were shown to visitors.

Improved techniques for tanning hides are also being developed and, to fight against cattle skin diseases, the Institute has made a collection of cattle hides, goat and sheep skins for identification of diseases.

An unusual investigation is into the reasons for the differences in the flavour of pineapple produced in different countries such as Malaya and Africa.

Wild tropical plants used in local medicines are also being examined in the hope that some will be found in which the active principle is of commercial value. A new cash crop could then be established.

One of the Institute's major long-term projects is aimed at improving the strain of pyrethrum for insecticidal purposes. Pyrethrins (the toxic part of the plant) have now been traced in immature seeds and it has also been found that fertilization of the flower does not influence the production of insecticide.

Commonwealth Economic Committee's Annual Report

The rapid evolution and continuing development of the Commonwealth are highlighted in the latest Annual Report (1960-61) of the Commonwealth Economic Committee.

New members last year were Nigeria, Cyprus, and Sierra Leone who, on becoming independent, accepted invitations to join the Committee. In view of the Committee's increasingly varied activities, member Governments decided to appoint a Chairman for a period of three years and Mr. M. Ikramullah, who has had a distinguished career in the Pakistan foreign service, accepted the position.

The Committee is an official Commonwealth organization, financed by Commonwealth Governments, which appoint their own representatives to the Committee. It is responsible to all these countries jointly.

More and more inquiries about subjects affecting Commonwealth trade are being answered by the Committee's staff. Examples of enquiries from official bodies showed the variety of subjects dealt with: carpet wools (Pakistan); trade in fresh pineapples (Ceylon); coffee statistics (Kenya, Uganda & Tanganyika Coffee Industry); spices (India); and sugar statistics (Fiji).

New Research Laboratory Will Help Fight Plant Diseases

A new laboratory which will be used by post-graduates attending the only nematology course of its kind in the British Commonwealth has been opened at Sunninghill, near London. Nematology includes the study of worms which attack plants.

Three years ago, the Imperial College of Science and Technology, London, started a one-year course in nematology. Professor B. G. Peters, who is in charge of the course, said that until this was started, there was no university in the Commonwealth which offered a concentrated course of this kind specifically for the study of plant nematodes. Overseas governments were now more aware of the insidious and recurring damage to plants which could be done by nematodes and were sending students to the course.

The erection of the new laboratory—known as the Shell Parisotology Building—has been financed jointly by Shell Chemicals Limited and the University Grants Committee.

British Scholarships for Commonwealth Students

178 candidates from Commonwealth countries overseas accepted scholarships offered by Britain in the 1960 competition—the first—of the Commonwealth Scholarship Commission in the United Kingdom.

The chief considerations of the Commission in selecting candidates are intellectual merit and a realistic and practicable plan of study but selections ensure that various parts of the Commonwealth are appropriately represented and that various fields of study are included among the awards.

Colonial Development Corporation Projects

The annual report of the Colonial Development Corporation reveals that, at mid-1961, the Corporation had 93 projects in hand in 26 different countries and territories. Some projects contribute to basic development—communications, power, housing and the like; some are concerned directly with primary production—agriculture, ranching, plantations, forests and mines; others are industrial projects mainly concerned with processing and manufacture.

When dependent territories achieve independence within the Commonwealth as in the cases of Ghana, Malaya, Nigeria and Sierra Leone, CDC is able to continue with projects started before independence. Furthermore, although the Corporation is not empowered to use its funds for new projects in these countries after independence, any Commonwealth government can invite CDC to advise or help with the management of development projects.

Federation of British Industries Urges More Post-Graduate Training for Overseas Students

The Education Committee of the Federation of British Industries—which has given many Commonwealth engineers scholarships for practical training in Britain—recommends in a report just published in London that ways should be found of bringing more graduate students from overseas to Britain for further studies.

Under the scheme engineers showing technical ability and leadership qualities are offered the chance of up to two years' practical training in British engineering works, with public utility undertakings, consulting engineers or contractors.

Second Commonwealth Education Conference Agenda

The Minister of Education, Sir David Eccles, led the United Kingdom delegation to the second Commonwealth Education Conference which was opened by Mr. Nehru at Delhi, on January 11, 1962. Accompanying him was Mr. Dennis Vosper, the Secretary for Technical Co-operation. Some 200 delegates from 13 Commonwealth countries and dependent territories attended.

One of the main items on the agenda was the possibility of co-operation in

extending the Commonwealth Scholarship and Fellowship Plan by awards for basic professional training not obtainable in the students' own country, for undergraduate study at universities and colleges of adult education, at technical colleges below post graduate level and for short-term visits of senior educationists.

Among other subjects discussed were the provision of textbooks, the teaching of science and mathematics, and the use of audio-visual aids, including television, in education.

Colombo Plan Trainees in Britain Double in Three Years

Britain's Under-Secretary for Foreign Affairs, Lord Lansdowne, said recently that the number of trainees in Britain under the Colombo Plan Scheme had doubled in three years. The need for technical training, said Lansdowne, was a problem not only of developing countries but of the developed ones as well. He went on: 'Practically all developed countries are short of technicians too, for it is, of course, a fact that the greater the reliance we place upon machines the higher is the demand for technical experts.'

Yams and Diosgenin

By S. S. Bampton

Summary

Cortisone and related compounds, a group of the modern 'wonder drugs', are largely prepared from diosgenin occurring in wild yams of the genus Dioscorea. This article reviews briefly methods of detecting diosgenin, and mentions some of the botanical and agricultural factors affecting its occurrence.

In 1949 the Americans Hench and Kendall[1] announced the dramatic effects of cortisone, one of the adrenal cortical hormones of animals, in treating rheumatoid arthritis. It was subsequently found to be of great value in treating skin disorders, eye infections, blood diseases and endocrine disorders as well as rheumatoid diseases, and it has been used with success for many other complaints. As with so many drugs there are, unfortunately, side effects in some cases but modifications of the compound have greatly reduced these so that cortisone and related compounds are still in great demand and it appears unlikely that this demand will decrease in the foreseeable future.

Following the discovery of cortisone's value, the problem of producing it at a reasonable price was tackled. Manufacture of the drug from animal sources proved impracticable for the demand, and its structure is so complex that synthesis from simple compounds could not be contemplated on a commercial scale. The big problem was to find a naturally occurring steroid of suitable structure preferably from vegetable or microbiological sources, and a fairly early success was obtained when Spensley and co-workers[2] devised a process for the manufacture of cortisone from hecogenin, a saponin occurring in the sisal waste which remains after the fibre has been decorticated. This compound is still used today for cortisone manufacture, but the discovery by chemists at Upjohn Co., U.S.A., that an oxygen atom could be introduced on to the 11 position of the unsubstituted steroid ring by microbiological means, enabled a new range of naturally occurring steroidal compounds to be considered as starters. The best of these, diosgenin, was discovered and named by a group of Japanese chemists in 1936 in the yam or Dioscoreaceae family, and had been converted to progesterone, an intermediate in cortisone manufacture, by Marker in 1940.[3] With the method of introducing the oxygen atom, the demand for diosgenin soared and botanists were sent to all parts of the world to search for suitable sources. Their success, coupled with that of the chemists, is shown by the fact that cortisone was first marketed in 1949 at about £1,500 per ounce, and is now available for about £12 per ounce.

Nowadays most cortisone is made from diosgenin extracted from Dioscorea yams, but supplies are short, and diosgenin fetches a high price.

Dioscorea Yam

[*Facing page 150*

Several countries are therefore considering, or have already started, commercial plantations of suitable yams.

Botany

The *Dioscorea* genus is found in the tropics and sub-tropics and is widely distributed throughout the world. Species occur on the Himalayan foothills and at sea level in North, Central and South America, in West African rain forest and in rather arid regions in Mexico. The plants have twining annual stems arising from underground or partly underground tubers, and it is from these tubers that the diosgenin is obtained. The plants are dioecious, i.e., either one sex or another, and bear sprays of very small and often inconspicuous flowers. Species can normally only be differentiated by detailed examination of these flowers, often microscopically, and owing to the short flowering season and the difficulties of collecting the flowers when they occur on a vine in the dense overhead cover, the genus is one in which there are undoubtedly, at present, a considerable number of unidentified species. The genus can usually be recognised easily by its habit and its characteristic paralled-veined monocotyledonous leaves. An example is shown in the plate. Some species, however, have divided tripartite leaves and these may well be overlooked by the amateur.

Collection

Fortunately the problem of identifying the species is not important if a territory is being surveyed for diosgenin-containing yams providing one species can be told from another and can be recognised again. The tubers are often of considerable value here as they are frequently characteristic of the species. Regrettably they are not mentioned in most floras. There are two difficulties in collecting the tubers, the biggest obstacle being tracing the aerial shoot to the ground. Frequently the lower part of the stem contains no leaves and is intertwined with numerous other climbers, making it exceedingly difficult to trace it to the ground. The other difficulty is getting the tubers out as they may weigh up to about 200 lb. and be some 3 ft. below ground. Most, however, only weigh a pound or two and are just below or even partly above ground.

Determination of Diosgenin Content

To determine whether or not a tuber is likely to be of interest commercially, the diosgenin content must be determined. This is a job for a skilled chemist, but an indication can often be gained by a simple method. In the plant, diosgenin is joined to a sugar molecule and is thus a saponin, a class of chemical compound which foams strongly when shaken with water. If, therefore, a small piece of the tuber is minced or ground, boiled with water in a test-tube for one minute, vigorously shaken, and then allowed to stand for three minutes, the presence of appreciable and persistent froth indicates a reasonable quantity of a saponin[4]; 0·1 g. of tuber in a 6 in. $\times \frac{1}{2}$ in. test-tube with 5 ml. water is satisfactory. This method is not infallible as foaming may result from a saponin other than one containing diosgenin, or even from something quite different, and the presence of

diosgenin will not always result in foaming. However, the method is very useful if suitable facilities are not available for better tests. A very rough guide can often be obtained by scraping the tuber with a knife, foaming being an indication of the presence of saponins. Saponins are bitter to the taste and it can be assumed that varieties which are normally eaten for food will contain none, or negligible amounts, of saponins.

Saponins also have the property of haemolysing blood, and this test can be used as an alternative to the above.[5] It is more difficult to perform and is not recommended unless the investigator has had experience of this test before.

The best test for a reasonably well equipped laboratory is a gravimetric test, which consists of mincing the tuber, extracting with methanol, hydrolysing the saponin with dilute hydrochloric acid and weighing the sapogenin precipitate.[6] It is often difficult to purify the sapogenin(s), and in order to obtain an accurate figure for pure diosgenin content, the sapogenin(s) should be acetylated and the infra-red absorption spectrophotometric method of assay used.[5] Diosgenin is usually expressed as a percentage of the dry weight, and the moisture content of an aliquot of the minced tuber should therefore be determined.

As a rough guide, a species with tubers containing more than 2 per cent diosgenin (dry weight basis) is of interest commercially. Whether it is actually worth exploitation depends on many factors such as the moisture content of the tubers, the ease of extraction of diosgenin, transport costs, etc. The market value of diosgenin is about £3 per lb. at the present time, and the value of the tubers varies from about £3 to £50 per ton, depending on the content of diosgenin and the other factors mentioned above.

Cultivation

The majority of diosgenin comes today from wild yams, but there is increasing interest in their cultivation. It is not a difficult crop to grow but the soil must be well drained, and support for the aerial parts of the plant is required. The greatest variety of yams seems to occur on well drained rocky limestone soils, although they are by no means restricted to this. With regard to support, canes, string and netting have all been used with success, but give rise to increased costs. The simplest method is to use canes from a local woody shrub or tree, which take root when put in the soil. These can be cut quickly, and when they take root are not liable to be attacked by termites nor require cross support. In some parts of the world paw-paw trees have been used as support, and elsewhere yams have been grown in rubber plantations, the rubber trees acting as supports. Some yams seem to prefer a shady habitat, although little information is available on the effect of light.

Propagation of the yams is by means of seed or pieces of tuber containing growing points or 'eyes'. In some species leaves or pieces of stem can be used also for propagation. Harvesting takes place after one or two years' growth depending on species, whether propagation is by seed or pieces of tuber, and whether one year's growth of tuber rots while the next is being formed. The plant is generally harvested at the end of flowering, before

die back of the foliage occurs, as it is at this time that the percentage of diosgenin seems to be greatest.

After harvesting, it is the usual practice in many producing areas to macerate and ferment the tubers for 1-21 days. This was reported[7,8] to lead to increased yields of diosgenin. More recently,[9,10] work has suggested that this apparent percentage increase is largely due to the decrease in the total solids after fermentation, but that fine comminution of the tubers leads to a very rapid enzymic increase in diosgenin which is not further increased by subsequent fermentation. These results were obtained with two species of *Dioscorea*, and it is perhaps unwise to assume that the same is true of all species. Certainly not all species give rise to an increase, real or apparent, on fermentation, and it would appear desirable to test any new species.

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The Infestation of Cowpeas in the Western Region of Nigeria

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Summary

An account is given of the damage suffered by cowpea through attack by bruchid beetles, and of the influence of marketing practices on the retail cost of the product.

In Nigeria most cowpea (*Vigna unguiculata*) is grown in the Northern Region, over 230,000 tons being produced annually.(1) Much of this is sent to other regions and in the year between 1956 and 1957 over 23,000 tons were sent from Kano by rail alone, and from various sources nearly 34,000 tons entered the Western Region by rail in the same period.(2)

In the area around Kano, cowpea is interplanted with guinea corn, being planted about July and harvested in October or November. The seeds are sold by farmers to Hausa traders who bag them and may either sell them by the single sack to other traders who retail them in the local markets, or to traders from southern Nigeria who may buy by the ton and send them, mostly by rail, to either the Western or Eastern Regions. In these southern regions they are sold by the sack to market traders who sell them, retail, in the local markets. Thus cowpeas consumed in Ibadan may pass through the hands of four middlemen before reaching the consumer. Each middleman takes a small profit and relies on a rapid turn-over for a reasonable income. A comparison between retail prices in Ibadan and those in Kano showed an increase of 30 to 40 per cent, and in Ibadan the retail price ranged from 3 per cent above the wholesale price when supplies were plentiful to about 10 per cent above it when supplies were scarce.

Cowpea seed is attacked by bruchid beetles. The attack begins on the farms when the pods are ripening and it is mainly by *Bruchidius atrolineatus*.(3) This infestation dies out during the early weeks of storage and, although the beetle is common on cowpeas arriving in Ibadan during the first few months after harvest, it is rarely found later. In the laboratory in Ibadan it is difficult to maintain a culture of the beetle on cowpea seeds. Infestation by *Callosobruchus maculatus* begins just before harvest and in the first few weeks of storage the beetle is not common, but the infestation grows rapidly in store and the species soon replaces *B. atrolineatus*.

Cowpea, in common with the seeds of other legumes, has a high protein content; about 25 per cent of the dry matter being crude protein(4). This makes it an important source of protein both for man and livestock.

Because of this and because of the volume of produce involved the condition of seeds offered for sale in Ibadan was investigated.

Sampling Method

Starting in December 1958, a sample of cowpea weighing about two pounds was purchased from a retail trader once a month. In July 1959 the frequency of sampling was increased to fortnightly intervals, and samples were obtained from four different traders. All the seeds in these samples were examined for exit holes made by adult bruchids; the holes per seed were counted and the moisture content of the seeds determined by using a Marconi moisture meter.

Results

The adults of both *Bruchidius atrolineatus* and *Callosobruchus maculatus* do not feed but their larvae do and are the only important pests attacking stored cowpea. Preliminary experiments showed that one larva of *C. maculatus* will consume about 5 per cent of a cowpea, so that a count of the exit holes made by the adults will give an indication of the loss which the cowpea has suffered. This method does not take into account the larvae which are feeding within the seeds. In the case of *C. maculatus* about three weeks elapse between egg laying and the emergence of the adult. The first of these weeks is spent as an egg and as a first instar larva which does little damage. Estimating damage in this way will therefore give an indication of the damage which the cowpea had suffered by a date between one and two weeks before the date of sampling.

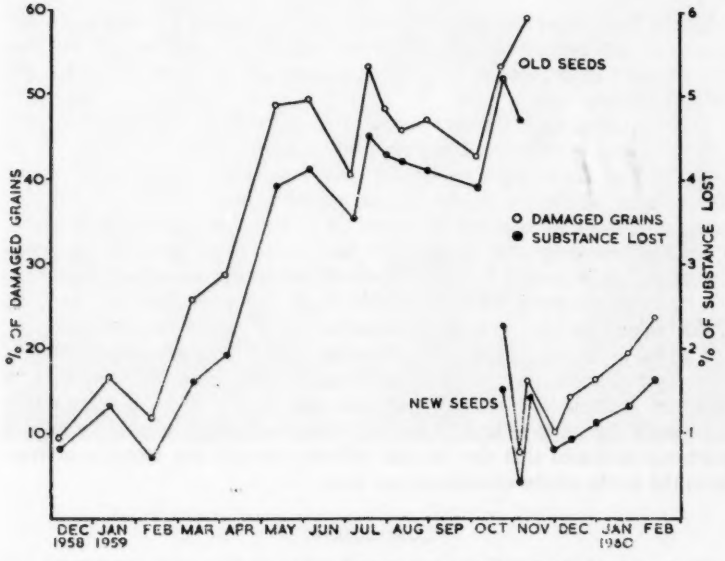

FIGURE 1. Damage to cowpea offered for sale in southern Nigeria at different times of the year

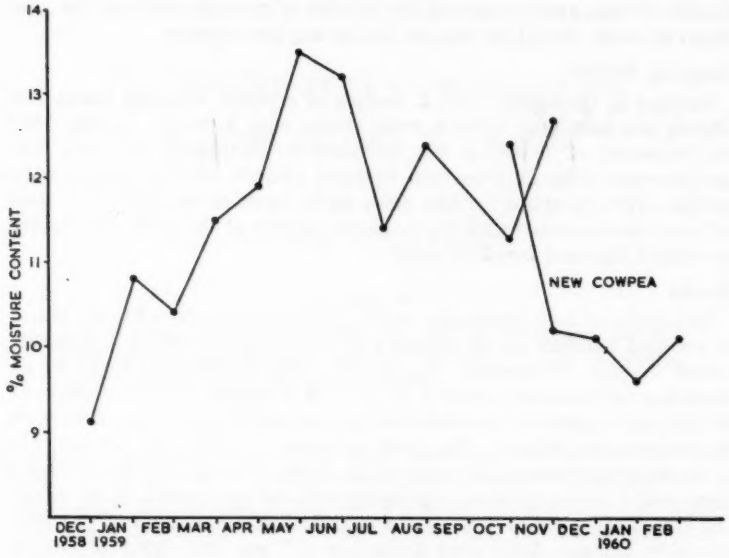

FIGURE 2. The moisture content of cowpea offered for sale in southern Nigeria at different times of the year

Data obtained by sampling is summarized in Figure 1 which gives the mean monthly percentage loss of cowpea, calculated by allowing 5 per cent loss for each emergence hole, and the mean monthly percentage of seeds with exit holes.

It is clear that some damage is present even at the beginning of storage. This is caused mostly by *B. atrolineatus* and amounts to a loss of about 1 per cent of the cowpea by weight, and a percentage damage of about 10 per cent of the seeds. As the period of storage lengthens, damage increases. This later damage is caused by *C. maculatus* and rises to about 5 per cent by weight of the cowpea lost, and 50 per cent of the seeds damaged. If it is assumed that the average loss for the season is 2·5 per cent and the annual production is 250,000 tons, the total loss will be over 1,500 tons of protein, as cowpea contains about 25 per cent protein.

The mean monthly figures for moisture content are given in Figure 2. The figures show that cowpeas arriving shortly after harvest have a moisture content of about 10 per cent and during the wet season this increases to between 12 and 13 per cent with an occasional sharp fall which probably indicates that the product offered for sale has recently arrived from the north where conditions are drier.

CONCLUSIONS

There are three problems associated with storage and marketing of cowpea in southern Nigeria. Firstly there is damage caused by insects,

PLATE I. Cowpea on sale in Ibadan Market

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PLATE II. Cowpea at the railway station, Ibadan

PLATE III. Showing holes made by adult bruchids emerging from the seeds

[*Facing page 157*

secondly there is a seasonal increase in price, and thirdly there is a considerable increase in price amounting to something between 30 per cent and 40 per cent between producer and consumer.

At all stages in distribution traders are unwilling to store cowpea in spite of the seasonal rise in price because they have neither the capital nor the equipment. Traders are also aware of increasing insect damage which occurs, particularly when cowpea is stored in urban areas. Many farmers around Kano seem to grow the crop mainly as a source of fodder for cattle in the dry season; the whole plant being kept in a bundle on the roof of the farmer's house and little attention being paid to the storage of seed for its own sake. Other farmers remove the pods and store them in rhumbus until required for sale in the market. Such prolonged storage as is done is of small quantities, often in isolated areas where there is a low rate of infestation by *C. maculatus*.

Bulk storage in bins which could be fumigated would help towards solving the problem of bruchid infestation. By fumigating cowpea early in the season it should be possible almost to eliminate the damage caused by *C. maculatus*. This would mean that the cowpea would only lose 1 to 1·5 per cent of its substance through attack by *B. atrolineatus*, which is a saving of about 22 lb. of cowpea per ton, if the average figure for loss by this species is taken as 2·5 per cent.

The cost of bulk storage on a limited scale could be borne by the seasonal increase in prices. The table gives the maximum and minimum prices for cowpea in an Ibadan market for the years 1954-59. These figures were obtained by finding the price of a sack of cowpea in the market at fortnightly intervals.

Maximum and minimum prices of cowpea in Ibadan in £ per ton

	1954	1955	1956	1957	1958	1959
Maximum . . .	70	37	47	67	53	45
Minimum . . .	29	28	27	35	31	29
Difference . . .	41	9	20	32	22	16

Only in 1955 did the change in price amount to less than £10 and in four out of the six years the increase was over £20. It would not be possible to store until the price had reached its maximum, because this occurs towards the end of the season, and an attempt to wait for it would almost certainly mean that stocks would remain unsold when the price fell at the next harvest. In a normal year a gross profit of £5 to £10 per ton could be expected if sale of stocks began after about six months of storage.

The capital cost per ton for storage would depend on the size of the installation and would be less as the capacity became larger. A bin holding 25 tons of cowpea would cost about £100 and a plinth for it would cost a further £20 to £25. A ramp or a mechanical device such as an auger would be needed for filling, which would cost a further £20 to £25, giving a total of about £150. Such an installation could be expected to last for ten years so that the annual cost would be about 12 shillings per ton.

Recurrent costs for filling and emptying would depend on the cost of labour or power, but it is unlikely that it would cost more than £1 to put ten bags of cowpea (which is about a ton) into the bin and run the same quantity out through a spout into the same bags later in the season. Recurrent cost of fumigation with a 1:1 mixture of carbon tetrachloride and ethylene dichloride would amount to little more than the cost of the materials, which would be about £3 for 25 tons, or under three shillings per ton. Drying would not be necessary since the crop is harvested in the dry season.

The total cost of storage per ton would therefore be about £1 15s., so that if the gross profit is taken as £5, the net profit would be over £3.

The capital invested would be about £150 for the installation, plus an annual amount of about £750 for 25 tons of cowpeas, making a total of £900. This would be slightly less each year as the bin was paid for. Net profit on 25 tons at £3 per ton would be £75 which is a little over 8 per cent. This is a reasonable profit; and it is unlikely that it would be much less; in some years it might be doubled.

A few installations of this sort in Ibadan would have little effect on the market price of cowpea but, on a larger scale, the effect would be to stabilize the price of cowpea in the market, once the holders of such stocks began to sell. This would reduce the cost to consumers in the later part of the season and so assist with the second problem of seasonal rises in price.

The third problem; that of reducing the increase in cost between producer and consumer is more difficult to solve. Some reduction might be achieved if the number of middlemen involved could be reduced. The price paid by the consumer will certainly fall if efforts now being made to find a variety of cowpea which can be grown satisfactorily in southern Nigeria are successful.

Acknowledgements

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Paint Research in the Tropics

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SUMMARY

The problems associated with the lack of durability and sometimes serious failure of paints in the tropics are studied at the Tropical Building Section of the Building Research Institute. Premature failure is sometimes caused by lack of care in preparing the surface and in applying the paint—defects associated with the employment of unskilled labour. Much depends, however, on the quality and composition of the paints used and the introduction of new, more durable paints with improved mould resistance is noted. Their evaluation over a period of trial and exposure testing is included in the programme of a number of independent organizations studying tropical building problems. A number of recommendations for good practice in tropical painting is made.

The great variety of tropical climates and the extent to which supplies of building materials vary in tropical regions gives the building industry many problems to solve. Not least of these is the reduced durability and sometimes serious failure of paints.

Paint coatings frequently have to serve the dual purpose of decoration and protection and, although their initial cost may be a very small percentage of that of the building, they are responsible for about half the average maintenance costs of building in all climates. Paints themselves have improved in quality very considerably over the last two or three decades, as a result of the introduction of scientific methods into what was once a craft industry. Nevertheless, they are still applied by the traditional craft methods and shortage of skill and craftsmanship is a very large contributory factor to failures of paint in many tropical territories.

To help those concerned with building in the tropics, the Building Research Station, at Garston, Watford, Hertfordshire, includes a Tropical Building Section which assists individual enquirers as well as governments. It publishes the results of surveys and research work both in Overseas Building Notes, which are sent to government and other organizations overseas with interests or responsibility in building, and in a series of Tropical Building Studies, published by H. M. Stationery Office. The fact that many of the enquiries relate to problems involving paint led, in 1957, to the establishment of a Tropical Paint Research Fellowship, paid for by Colonial Development and Welfare Funds. The duties of the Research Fellow were to make visits abroad and investigate the true incidence of and reasons for paint failures; to consider any improvements needed in

the paints themselves, and to recommend to Overseas Government Departments ways in which their maintenance costs of painting might be reduced and better results obtained.

The recent encouragement of industrialization, particularly in territories becoming independent, has led to the setting up of local paint factories. It is, however, rare for any indigenous raw materials of the territory to be found useful or economic in producing modern types of paints.

Paint Problems

The durability of even the best modern paints may fall short of requirements in extreme climatic environments, but premature failure is mainly caused by incomplete surface preparation and faulty methods of applying the paint, defects which are bound to occur when there is so little skilled labour. This state of affairs can only be remedied by better craftsmanship which in turn depends on increasing the number of supervisory personnel and on more and improved facilities for training in the building trades. Careful attention to design can also prolong the life of painted surfaces.

Nevertheless there is scope for the improvement of paint, and the United Kingdom paint industry, which is export conscious and very successful in this field, is constantly seeking to modify its products.

It is generally believed that 'fungus' is the principal tropical painting problem. This term is used by the man in the street to include two rather different types of organism: the moulds and the algae. The former are plants lacking chlorophyll which grow on organic sources of carbon (including paints) both internally and externally. Unlike many 'green' moulds, the principal paint-infecting moulds are resistant to ultra-violet light. The other type of organism, the algae, are green plants and can photosynthesize their food from carbon dioxide and water. They flourish in continuously wet conditions on the surface of buildings, particularly roofs and parapets. Although paints may be used in such a way as to reduce the tendency of the surface to hold water and thus obtain resistance to mould growth, very much more can be done by correct design of buildings and fittings to obviate this trouble. On the other hand, mould growth on paints cannot readily be avoided by design details, and the composition of paint needs altering to make it less easily assimilated by the organisms or positively toxic to them. A large number of toxic compounds for inclusion in paints have been proposed, including organometallic derivatives of copper, mercury and tin, chlorinated phenols and organic sulphur compounds. Some of these are reasonably effective for interior use in industrial buildings such as bakeries and breweries. Unfortunately these compounds are lost rather rapidly from the paint film when exposed to outdoor conditions, and so far it has not been found possible to produce paints for outside use in the tropics with a life free from mould equal to the protective life of the paint film. The majority of mould attacks in the tropics arise from surface contamination and give rise to a dirty appearance, rather than to marked deterioration or degradation of the paint, so that it is loss of decorative effect with which the user is concerned. Occasionally, however, mould growth erupts through the film and causes damage.

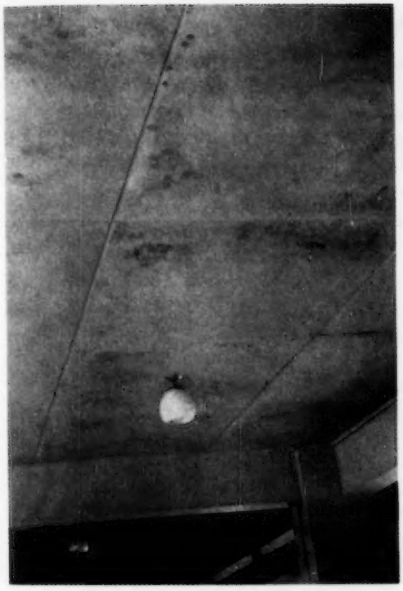

PLATE I. Mould growth on painted ceiling, Ibadan.

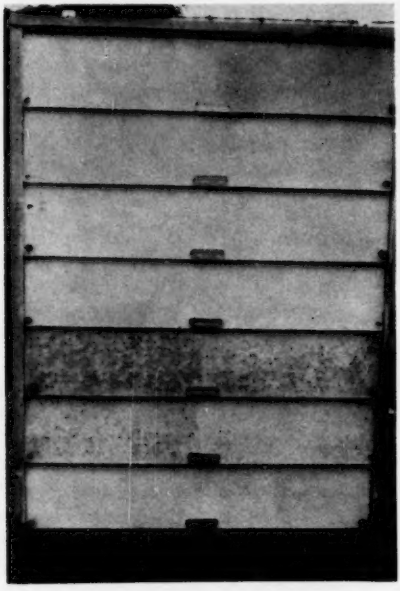

PLATE II. Mould growth on painted test panels, Florida

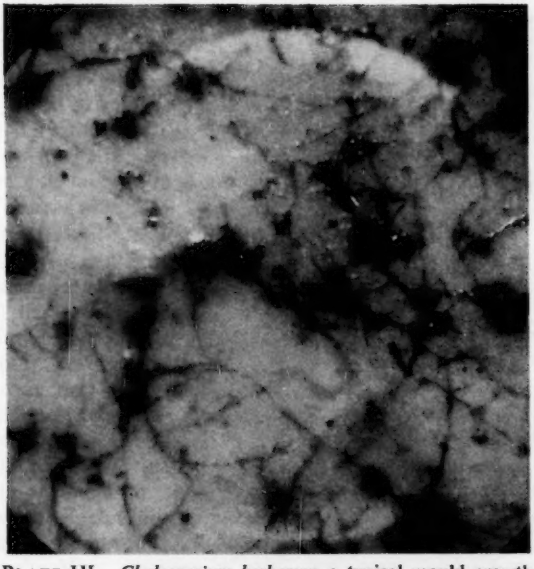

PLATE III. *Cladosporium herbarum*, a typical mould growth in the tropics, 50 times magnified

[*Facing page 160*

One type of paint, however—that based on zinc oxide—is quite highly resistant to the growth of mould, and has been used extensively, for example in the West Indies, on timber buildings. Unfortunately, it is not suitable for the protection of steel, nor for the brightly coloured, glossy, enamel type of finish which is favoured in modern building practice.

Conclusions

Present development of tropical paints is concerned with the search for new toxic compounds of greater permanence, but also with the re-introduction of the zinc oxide paints in a modified form for certain purposes. The conclusions which the Research Fellow's work has produced so far are therefore:

(1) The reduction in overall durability of paints in the tropics is largely caused by misuse, that is, inadequate preparation and application, combined frequently with the use of the wrong type of paint or a paint not entirely suitable to the job in hand. Such difficulties can only be met by education (in the widest sense of the term) of all those concerned in specifying, purchasing and using paint. In particular, trade or technical training of operatives, as in other fields of building, requires urgent attention.

(2) Paints of greater durability, and particularly of improved mould resistance are required. Their provision involves solving problems which the paint manufacturers are fully willing to tackle, but buyers cannot reasonably expect to purchase such improved paints at the lowest market prices.

(3) It would be helpful if a more enlightened attitude could be adopted towards expenditure on paint and painting. The best paints will not be obtained by the present common system of purchasing those of the lowest price, although the inverse proposition is not necessarily true. Greater initial expenditure would considerably reduce subsequent maintenance costs and would be technically desirable. Economic factors, such as the limitation of capital expenditure and the annual allocation of maintenance funds, are however, allowed to over-ride the technical considerations.

It is hoped to publish in the near future a guide to good practice in tropical painting, based on these observations and conclusions, and this should fill the gap now existing because the British Standard Code of Practice for Painting is only applicable to the temperate climates of Great Britain.

The introduction of new surface coatings based on the products of the plastics and polymer industries is a feature of the British paint market. Overseas countries will naturally wish to take advantage of such developments, but a period of trial and exposure testing will generally be necessary before such products can come into use. The Research Fellowship is one of the ways in which independent sources of information of this type can be obtained. Among the many organizations working on tropical building problems, the West African Building Research Institute, Ghana, the National Building Research Institute, South Africa, and the Central

Building Research Institute, India, include evaluation of paints in their programmes. The first-named co-operates in the exposure testing of paints with the Tropical Paint Research Fellow.

Of the newer developments, the latex emulsion paints, based on polymers such as polyvinyl acetate, have already found ready acceptance in the tropics, where their ease of application is a most useful feature. On the other hand the resins of the epoxy and polyurethane types have special requirements in respect of application which makes their introduction far more difficult. It can confidently be predicted, however, that there will be as many changes in the paints in use in the tropics ten years from now as there have been in the last decade, and it is up to the peoples and governments of these countries to improve the skill of building tradesmen so as to obtain the benefits of these innovations.

The Acceptability and Fitness of Maize for Human Consumption

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SUMMARY

Symptoms of pellagra in man are often observed where maize is the staple food in the diet. Maize meal has a very low nutritive value and deterioration of maize and maize meal could accentuate the development of dietary deficiency symptoms. Reference is made to experiments designed to detect such deficiencies in rats and pigs as a result of feeding these animals with various types of maize meal. The palatability of these meals to East Africans has also been investigated.

Maize Meal as a Staple Item in the Diet

Under certain circumstances, where maize (*Zea mays* L.) provides the main supply of calories (80-90 per cent) and nicotinic acid in the diet of a population, the clinical symptoms of the nutritional deficiency disease, pellagra, become apparent[1].

The clinical symptoms of pellagra have been given in reports by members of the Department of Human Nutrition[2] and are of the general pattern associated with malnutrition such as weakness, abdominal discomfort or pain and headache, loss in weight, a characteristic form of skin lesion which occurs on exposure of the skin to sunlight, swelling, redness and ulceration of the lower lip and a fiery red tongue.

Some or all of these symptoms are often associated with changes in the method of preparing the whole maize for consumption as cooked maize meal. The old method, carried out by the women of the village, has been described for at least two African territories, Tanganyika[3] and Nyasaland.[4] The maize is dampened slightly and given an initial pounding in a pestle and mortar to loosen the bran from the endosperm. The bran is removed by winnowing and the remaining endosperm is soaked in water for several days. This has the effect of softening the grain and inducing germination.[5] Germination takes place to a small extent and, among other nutritional benefits, makes the nicotinamide present available as nicotinic acid. The softened endosperm is pounded to a fine meal which is highly acceptable and smooth to the palate when cooked. It contains only 0·3 to 0·5 per cent fibre[1] and none of the bran which is said to give an unpleasant taste to the porridge.[6] The germ is removed with the bran and these are often separated, the germ being boiled and eaten as a separate dish.[4]

The new method of preparing maize involves the milling of unwashed,

but possibly sieved, whole maize, in hammer mills at traders' premises. The meal produced by this method contains a high proportion of bran consisting mostly of fibre (2·0 per cent fibre in the meal[1]) and also of dust, grit and insect fragments. These 'contaminants' are indigestible and the meal lacks the nutritional benefits made available by the soaking method.

The use of roller mills is becoming more widespread and is efficient since the process ensures pre-cleaning and removal of bran; this meal, in comparison with the product from the hammer mill, is a clean, fine meal with a low fibre content (Grade I, from a mill in Nairobi, contains 0·35 per cent fibre) but is low in nicotinic acid.[7]

It is now generally held that the meal made and prepared by the African is usually greatly preferred by the consumer to all the other meals and it is suggested by Dr. Raymond (personal communication) that it may well be nutritionally superior to the highly milled meal turned out by roller milling or to the whole milled maize turned out by hammer mills.

Analyses[7] have shown that highly refined meal contains about 6·0μg/g of nicotinic acid, 72 per cent extraction meal contains about 14·6μg/g and whole ground meal is found to have a nicotinic acid content of 20·0μg/g.

Pellagra has been associated with a deficiency of tryptophan of which there is a shortage in zein, the main protein found in maize. The available information on 'Pellagragenic Diets' has been summarized,[1] the general conclusion being that 'pellagra is caused by a tryptophan/nicotinic acid imbalance deficiency which responds to treatment with nicotinic acid, provided there is sufficient of the essential amino acid (tryptophan) present in the diet'. It was also stated that tryptophan can be used as a supplementary source of nicotinic acid provided sufficient, 200-300 mg. tryptophan daily, is available.

It can be expected that a diet of highly refined maize meal, where the nicotinic acid content was only 6·0μg/g would lead to nutritional disorders associated with pellagra. But, it has been noticed by expert observers (Applied Nutrition Unit) that a diet of whole ground maize is often associated with symptoms of pellagra, despite the fact that the whole meal contains more nicotinic acid than the refined meal.

There are several possible reasons[8] for the development of these symptoms in subjects feeding mainly on a whole maize meal diet. First, the amount of nicotinic acid present is insufficient and needs to be supplemented from other food sources rich either in the vitamin or the amino acid tryptophan.[1] Secondly, the presence of comparatively large amounts of fibre (2·1 per cent) in whole maize meal may prevent the absorption of vitamins.[9] Although there is a difference of only 0·4 per cent less fibre in sorghum than in maize[7] the Basutho[1] changes his diet from maize to sorghum whenever pellagra occurs. However, whole sorghum meal contains 39 μg/g nicotinic acid which is almost twice as much as that in whole maize meal.[7] Thirdly, it has been suggested that there is a toxic or pellagra-producing factor in the bran of maize, but this seems unlikely according to Kodicek[10] who has reviewed the whole subject of nicotinic acid.

Evidence has been obtained that pigs fed on maize exhibit similar pellagragenic symptoms to those found in man. At autopsy,[11] lesions

have been found in the large intestine which were characteristic of nicotinic acid deficiencies. It has also been shown[12] that 30 to 90 per cent maize in the diet of a pig means a smaller gain in weight. However, it is unwise to extrapolate to human beings the results obtained with animals.

Deterioration of Maize and Maize Meal during Storage

In many overseas territories in the British Commonwealth, maize, which is usually of the white flat dent variety, is the staple diet of the population. During its storage either on the cob, as shelled maize, or as meal, deterioration or spoiling can take place. Spoilage may result from excessive moisture in the grain,[13] which permits the development of micro-organisms, from insects and from the method of milling.

Whole maize deteriorates more rapidly than wheat, possibly because of its higher normal rate of respiration[14] resulting from its higher moisture content: relative humidity equilibrium compared with that of wheat. The respiration rate of maize increases rapidly with moisture contents over 14·5 per cent.[14]

Respiration is said[15] to cause the conversion of starch to dextrin and maltose, of proteins to peptides and of amino acids and fats to fatty acids and glycerol. The reactions are catalyzed by enzymes present in the maize cells which are activated when these are damaged (e.g. possibly by shelling) and the rate of deterioration increases.

Bacteria are only associated with deterioration in grain at high moisture contents and more especially when it is stored under anaerobic conditions.[16] Investigations at the Pest Infestation Laboratory,[17,18] however, have shown no definite correlation between numbers of bacteria and moisture content during hermetic storage, although fungi are considerably reduced in proportion to the moisture content of the grain.

There is a general consensus of opinion in the literature cited that, at moisture contents above 14·5 per cent, when maize begins to respire at a faster rate, the conditions become favourable for the multiplication of fungi and that the lipases produced by the moulds are almost solely responsible for increases in the acidity of the fat (acid value*). Correlations between moisture content, fat acidity and growth of mould on wheat have been obtained by Milner, Christensen and Geddes.[19] The same authors found that the lipases naturally present in the wheat grain, play a very small part in fat deterioration. This has been confirmed for maize[20] and for a variety of grains.[21]

As moulds develop, acidity of the fat in maize is said to rise to a peak and then fall.[20] This occurs especially at very high moisture contents, such as 31 per cent.[16] Correlated with these changes in acidity are decreases in non-reducing sugars which, according to the American workers, are a more reliable index of deterioration than acidity of the fat. Nevertheless, experiments have shown[22] that acid value is a more sensitive index of deterioration, especially that resulting from insect attack, than are changes in water soluble acidity, phosphate acidity and amino acid acidity.

* Acid value is here defined as the number of milligrams of KOH required to neutralise the free fatty acids from 100g. grain.

The fat acidity of good quality grain is dependent to a very small extent on the moisture content at the time of analysis.[23] However, the acid value of good quality grain is very much lower, (10-30) than that of 'spoilt' grain (200-300) and under these circumstances, differences in moisture content at the time of analysis causes insignificant differences in results in fat acidity and can be ignored.

It is interesting to note that, although the acidity of stored maize increases, the pH does not alter until other changes are far advanced, due to the buffer action of the proteins and other constituents of the grain.[15]

During the storage of maize meal it is thought that oxidation of the essential fatty acids takes place, resulting in rancidity. This has been defined[24] 'as the deterioration on storage of an oil or fat, characterized by an "off" odour or flavour'. The factors which are characteristic of rancid oil are however thought to be present in grain in only very small quantities (W. D. Raymond, personal communication) and have not yet been analyzed in grain.

Insects infesting maize are responsible for considerable weight losses[25] and their presence labels the maize 'spoilt'. As the insects feed and increase in numbers on the maize, not only is the grain contaminated by the products of insect metabolism but also by insec chitin. Maize grains are broken as a result of insects feeding and a considerable quantity of dust (e.g. 2 to 3 per cent)[26] is produced which can be assumed to have a high acid value.[27]

Deterioration in cracked and broken maize takes place at a faster rate than in whole maize under the same conditions of temperature and humidity.[28] This is probably because enzymes are liberated when the cells are lacerated. The deterioration of maize meal is probably almost complete in 12 months storage[29] and is characterized by the denaturation of the proteins. Since these denatured proteins are as a rule more digestible than the native proteins, it has been suggested[29] that in rat feeding tests the smaller gains in weight must partly be due to impaired palatability. In the same series of tests increases in fat acidity were noted but were not related to changes in palatability. So far as smaller weight gains in cattle fed with maize are concerned, it has been stated[29] that Vitamin A is destroyed during storage of whole maize (in particular yellow maize) and, when fed to cattle, symptoms of anasarca, which are indicative of a lack of Vitamin A, become apparent.

In the milling of maize meal insects are frequently ground in with the meal, especially in territories where the hammer mill is used. The eating of meal which is heavily contaminated with insect chitin and excreta has been said to result in 'stomach upsets' in man[26] although, if well cooked and softened, chitin would probably not do any harm, (Dr. Hunter, Assistant Director of Medical Services, Uganda, personal communication). The presence of mites in processed foods has, however, been known to produce allergic symptoms and diarrhoea in man.[30]

Once maize is ground into meal the separation of adulterants is not easily accomplished and visual assessment of the quantity of adulterant is impossible. Several laboratory methods are available for assessing insect contamination in maize meal and are as follows:

(1) Estimation of insect fragments.
(2) Determination of uric acid as an index of filth contamination in stored grain.
(3) Determination of phenolic substances present in insect chitin.

An estimation of the insect contamination of the meal, gives an indication of the level of infestation in the maize before milling. A survey of the insect fragment contamination of maize meal being milled in Central and East Africa was carried out from the Pest Infestation Laboratory[31] and this showed gross differences in levels of contamination of meal in different areas. Counts of this nature are not an accurate assessment of the number of insect fragments present; laboratory experiments with meals prepared from previously infested materials have shown that a complete picture of contamination is not given.[32]

An excretory product of insects, i.e. uric acid, has been used by other workers[33] as an index of filth contamination in stored grains. However, it has since been shown[34] that substances other than uric acid are present in wheat flour, which give apparent uric acid reactions with Benedict's reagents.[35]

The determination of phenolic substances presents difficulties, and, as has been reported,[36] considerably more work needs to be carried out to perfect this method.

Chemical changes constituting deterioration in stored maize are catalyzed by enzymes and, for purposes of the experiments described, some method other than heat sterilization to kill the naturally occurring insects was necessary. Fumigation with methyl bromide has been used for this purpose, although the full chemical effect of this treatment has not been investigated. In its application to groundnuts[37] (10 and 30 mg./litre per 24 h. at 30°C) the tip of the radicle was destroyed and germination was therefore impaired by low dosages of methyl bromide (131 parts per million) at high moisture contents (14·0 per cent.). At low moisture contents (5 per cent.) three times the dose of methyl bromide (377 p.p.m.) did not affect germination. Workers in the United States[38] using 72 mg./litre per 24 h. at 18°C have also found moisture content thresholds above which germination is impaired by methyl bromide.

Experiments

Experiments designed to give some indication of the effect of feeding insect-contaminated maize meal to growing rats and to a pig and of its palatability to human beings have been undertaken in the U.K.

The meal was prepared and the insect fragment count determined at the Pest Infestation Laboratory. The meal was fed to rats by Dr. P. L. Pellet of the Human Nutrition Research Unit, Medical Research Council, Mill Hill, and analyses of the fat acidity* were carried out at the Tropical Products Institute, London.

Palatability tests using human beings were carried out in East Africa by the Government chemist in Kenya and Tanganyika and at the Animal

* Fat acidity is defined here as the number of milligrams of potassium hydroxide which will be required to neutralise the oil extracted from 10 g. maize, calculated on a dry weight basis.

Health Centre in Uganda. The meals were prepared at the Pest Infestation Laboratory and chemical analyses were again carried out by the Tropical Products Institute.

Insect-Infested Maize Meal and Artificially-Acidified Maize Meal Fed to Growing Rats

The effect upon the growth of rats of a diet of insect-infested maize meal, with a high acid value resulting from the presence of insects, was investigated. Five types of meal were prepared by finely grinding infested maize (200 adult *T. castaneum* per 100 g. maize stored for three months) and also uninfested maize. The latter was divided into three sub-samples; one of these was acidified with hydrolized maize oil, a second was mixed with neutral maize oil, the third was untreated. These samples were analyzed for oil content, fat acidity, moisture content and insect fragments; methods described by other authors[32,39] were modified.

The rats were fed diets prepared from 96 per cent maize meal and 4 per cent salt mixture. Weanling rats were used and dosed with fat-soluble vitamins each week. Five experiments were carried out with six litters of rats and, for each experiment, six rats, one from each litter, were used. They were housed individually on wire screens and fed *ad libitum* on one of the five types of meal, the food consumption being recorded for 21 days.

An analysis of variance of the weight gains of the rats during 21 days' growth demonstrated that the animals grow equally well upon all five diets, and the analysis of variance of the food consumption during this period showed that none of the diets were significantly different. Thus, under the conditions of the experiment, it has been shown that neither insect infestation nor artificially high fat acidity in the maize samples produce any differences in growth or in the food consumption.

Since the growth obtained upon all five diets was poor, due to the low proportion of good quality protein in the diet, the experiment was repeated with diets prepared containing 85 per cent maize meal and a higher level of protein. Again there was no significant difference in the weight gains of rats fed various maize treatments.

This work indicates that neither insect infestation nor artificially high fat acidity produced any effect on the weight gain of weanling rats.

Palatability Tests of Maize Meal in Kenya, Trinidad and Uganda

The purpose of the palatability tests was to determine whether maize meal stored for different periods of time would be acceptable to Africans in Kenya, Uganda and Tanganyika.

Three types of meal were used in this experiment. One was prepared from a sample of maize, infested with *T. castaneum* (200 adults per 100 g. of grain were allowed to breed for three months); a second from a sample of uninfested maize, a third from a sample of uninfested maize to which dead adults of *T. castaneum* (200 per 100 g. of grain) were added. All three samples were ground separately in a hammer mill.

The maize meal was stored at 30°C and 70 per cent relative humidity. Small sub-samples were dispatched at intervals to the three East African territories, the first to arrive in about three days and others 24 and 52 days

after grinding in the U.K. Before dispatch, sub-samples were also taken for chemical analyses and insect fragment counts.

In Uganda the tasting panel, numbering 33, 34 or 36 people, consisted of Africans from the West Nile District who were given the meal cooked with salt and cassava (proportion 1:2) and also of Africans from a number of Districts who were given the meal cooked with salt only.

In Kenya the meal was prepared in the local way with salt added by an African Laboratory Attendant under the supervision of the Government chemist and was tasted by a panel of six Africans. They found that the meal under test was of a coarser consistency than the local meal, but in differentiating between the test meals the panel was asked to comment on the flavours only.

In Tanganyika the meal was prepared in the local manner by the African Senior Chemical Assistant who had previously prepared meal for local organoleptic tests. The number of Africans on the panel which tasted the meals in this experiment varied considerably; they were recruited from the staff of a laboratory.

The results of the tasting tests carried out in the three territories were widely different although, as can be seen from the table, each individual panel reacted in a consistent manner to the test samples.

Maize meal with a fat acidity of up to about 10·0 mg. KOH per 10 g. of meal was thought to be sweet and good and to have no taint. Meal with a fat acidity of about 17 was liked, although thought to be slightly musty and sour, and that which had an acidity of over 20 was considered bitter and sour as well as slightly musty.

TESTS ON THE PALATABILITY OF MAIZE MEAL CARRIED OUT IN EAST AFRICA

(K—Kenya; U—Uganda; T—Tanganyika)

Storage period days	Territory	Infested*			Uninfested*			Uninfested, with dead insects*		
		Fat† Acidity	Like	Dislike	Fat† Acidity	Like	Dislike	Fat† Acidity	Like	Dislike
3	K	22·8	0	6	7·2	6	0	—	—	—
	U		16	20		31	5		22	14
	T		4	8		6	6		—	—
10	K	31·4	0	6	10·4	6	0	12·6	—	—
	U		8	26		28	6		28	6
	T		11	0		11	0		—	—
24	K	35·1	0	6	17·1	6	0	17·3	—	—
	U		16	17		22	11		14	19
	T		12	0		12	0		—	—
52	K	36·8	0	6	21·5	6	1	21·8	—	—
	U		8	26		19	15		30	4
	T		12	0		12	0		—	—

* Condition of maize prior to grinding.

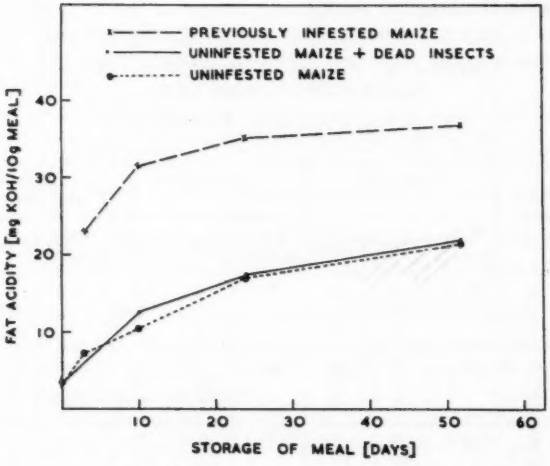
† Fat acidity—the number of mg. KOH required to neutralise 10 g. dry meal.

The fat acidity of the meal prepared from previously infested maize was high, 22·8, after only three days' storage and had increased to 36·8 after 53 days' storage. This meal was liked by the whole of the Tanganyika panel and would be eaten, if there were no alternative, by the panels in Kenya and Uganda although they thought the meal was bitter, sour and musty.

It is indicated in the figure that the fat acidity of the infested and the uninfested meal increases at approximately the same rate. The initial higher fat acidity of the meal prepared from previously infested maize is probably due to the quantity of dust and frass produced by the insects and ground up with the maize. The addition of ground-up dead insects which had been killed by heat does not appear to have affected the fat acidity of the meal; it is possible however that chemical changes in the meal may have resulted from the addition of ground-up dead insects which had been killed by means other than heat.

Insect fragment counts showed that the uninfested maize meal was contaminated by about 500 fragments in 10 g. of dry maize meal. This was due to a primary infestation of *Calandra oryzae* inside the maize grains and although just before grinding, the maize was hand sorted, some grains containing developing larvae were unavoidably allowed to pass.

The number of insect fragments in samples from previously infested maize was approximately 5,000 per 10 g. of dry meal and, in meal prepared from uninfested maize to which dead insects were added, there were between 2,000 and 4,000 fragments.



Increase in fat acidity of maize meal occurring during 52 days storage at 30°C and 70 per cent relative humidity

Maize Meal Fed to Pigs

The purpose of this experiment was to compare the apparent nitrogen digestibility of uninfested and infested maize meal, i.e. to show whether

the presence of insect chitin, etc. affected the digestibility of nitrogen by pigs.

Two samples of maize meal were prepared as in the other experiments, one from whole maize which had been infested with *T. castaneum* adults (200 adults per 100 g. maize for three months) and the other from uninfested whole maize. The experiment in which two pigs were used was carried out by Dr. P. L. Pellet of the Human Nutrition Research Unit.

Neither pig would eat the meal and one lost one kg. in weight during the experiment.

Conclusions

It is not generally known that maize meal is a poor substitute for wheat flour, and that to make up for its deficiencies, foods especially rich in proteins and B-Vitamins need to be added to the diet.[40] Because of climatic and other factors, maize is the easiest crop to grow in many countries and is the staple in the diet. It is in these countries that other foods are not as cheap or as easy to obtain and deficiency diseases become apparent.[1]

Further nutritional deficiencies may also occur from deterioration in the maize due to attack by insects. Infestation can be a problem even in countries where the period of storage is short (e.g., where there are two crops every year) the maize being attacked before and after harvest. Most of the damage due to insects takes place during storage.

Insects feeding on maize cause loss in weight of the whole grain.[25] The effect of this is often masked because frass and dust remain inside the grain. The dust has a high acid value, as can be seen from analyses of meal prepared from highly contaminated maize, and when ground with the whole maize during milling, produces a meal which humans may find unpalatable.

Tests carried out in feeding maize meal to young rats did not show a difference in nutritive value between insect-infested and uninfested maize because maize meal appears to have been an unsuitable food for rats, their growth having been very poor even when the diets were enriched with protein. The pig, which is supposed to be nearer to man in its nutritional requirements than any other animal, was therefore used in similar feeding tests. In these the pig would not accept the meal and the effect of insects on the nutritive value of maize therefore requires further investigation. Moreover, since the results should not be extrapolated to human beings, still further work is required on this aspect.

Palatability tests carried out on maize meal in Kenya, Tanganyika and Uganda gave well-defined results when the differences in the kind of people on the tasting panels and the different methods of cooking the meal are taken into account. In some cases, especially in Tanganyika and Uganda, it is possible that those tasters who were used to a lower standard of living, accepted meal which was unacceptable to others. It was also possible, especially in Kenya, that the panel became conditioned to the meals, both to its taste as well as its colour (see table).

The acidity of the uninfested meal was initially much lower than that of the infested meal (see figure).

Since the highest acid value of uninfested meal (21·5 mg. KOH per 10 g. dry meal) was lower than that of the lowest value of the infested meal (22·8) the tests carried out on the two meals were not strictly comparable. However, since the acid values of the uninfested meal and the uninfested meal plus dead insects were similar and the results of the tasting tests were all similar, it may be assumed that insect chitin alone did not affect the palatability of the meal. The presence of insect frass, therefore, apparently caused the meal prepared from previously infest maize to be unpalatable.

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The Market for Vanilla Beans

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Summary

The market for vanilla beans is reviewed. It is unstable, being characterized by rapid price changes resulting from fluctuations in supplies. Statistics of production by the main exporting countries and of consumption in selected importing countries are given and the uses of vanilla, mainly in foodstuffs but also in perfumery and various pharmaceuticals, are described. The strength of the competition from synthetic substitutes, particularly vanillin, is evaluated. It is concluded that market prospects are uncertain because of developments in Madagascar which has greatly expanded production. At the same time Madagascar has introduced a scheme for orderly marketing but it is as yet too early to say how effective this will be.

Production of Vanilla Beans

The vanilla beans of commerce are derived mainly from *Vanilla planifolia* Andrews; this species is the source of the Bourbon (Madagascar, Réunion and Comoros), Mexican and Java vanillas. Tahiti vanilla, produced in French Oceania, is derived from *V. tahitensis* J. W. Moore. The West Indies produces vanilla from *V. planifolia* Andrews, and also an inferior form of vanilla from *V. pompona* Scheide.

World demand for vanilla beans has been relatively stable over the years, but supply has fluctuated considerably, partly as a result of climatic conditions. Thus the failure or partial failure of one of the principal crops is not uncommon, and in 1953-55 there was a partial failure for three successive years of all the main crops. Supply also fluctuates because growers increase or reduce production in response to changing prices. Given the right conditions, the vanilla plant can come into bearing in one to two years, and it may continue to bear for a considerable number of years, depending on soil conditions, cultural factors, severity of cropping, etc. The relative shortness of the period before bearing means that, provided climatic conditions are favourable, supplies of vanilla beans can be increased fairly readily if prices are high. The perennial nature of the plant means that there is always a latent reserve of vanilla beans which can be brought into production when required. That is to say, when prices are low many growers, and particularly those small holders to whom the production of vanilla beans is only a subsidiary activity, are not encouraged to undertake the labour involved in production, but when prices

become attractive these dormant resources are once more exploited. There is, therefore, a considerable element of elasticity in supply; demand is relatively inelastic. Moreover, no regulation of production or, until very recently, of marketing has been applied to vanilla. The result of these factors is that the vanilla trade is characterized by a cyclical pattern of excessive supply followed by acute scarcity. The best illustration of the cyclical nature of the vanilla trade is to be found in the history of price variations which is given in the section on prices. It should also be pointed out that, owing to the inelasticity of demand, even very low prices may not clear the market and unsaleable stocks may accumulate in the countries of origin. Thus in 1948 over 600 tons of vanilla beans had to be destroyed in Magagascar.

The world's largest producer of vanilla beans is Madagascar, whose production in recent years has been as follows:

	Metric Tons
1956	692
1957	431
1958	476
1959	350 (Estimated)
1960	300 (Estimated)

The reduced production in 1959 and 1960 was the result of cyclones: the general trend of production is upwards, due to a long-term 'regeneration' policy for the industry. As a result of this policy, it is expected that production will reach the levels of at least 600 metric tons per year as from 1961. Regulations in Madagascar do not permit any export of beans out of a new crop to be made before January of the year following the harvest. This expanded production of 1961 may be expected to begin appearing in world markets in March/April, 1962.

Tahiti and Mexico both have an annual production varying between 100-150 tons, while that of the Comoros varies between 50 and 100 tons. Smaller producers are Réunion (about 50 tons), Guadeloupe, Indonesia and certain Commonwealth countries, such as British East Africa; the output of British countries is small, and their combined production may not be more than 20 tons per year.

International Trade

World trade in vanilla beans is largely dominated by the requirements of the United States market. About 800 to 850 tons of vanilla beans enter international trade in most years, and of this quantity some 500 tons or more are imported into the United States. France, the United Kingdom and Western Germany are also important markets. Table I, relating to 1956, shows the distribution of exports from the main producing countries and from France.

As the table shows, exports from Mexico, Dominica, the Seychelles, Indonesia, Madagascar and Guadeloupe were largely destined for the United States, whilst exports from Réunion went principally to France, and virtually all Uganda's exports were shipped to the United Kingdom. Although this pattern may change in some respects from year to year, chiefly with regard to the amount of vanilla beans shipped to France it is, generally speaking, not untypical.

TABLE I

Export trade in vanilla beans in 1956 (*in tons*)

From \ To	Importing countries					Export Totals
	U.S.A.	France	U.K.	Germany	Others	
Mexico	88	—	—	—	—	88
Dominica	17	—	—	—	1	18
Uganda	—	—	2	—	—	2
Seychelles	5	—	2	—	—	7
Indonesia	9	—	—	—	—	9
Madagascar	338	31	—	7	—	376
Réunion	17	49	8	7	1	82
Guadeloupe	5	—	—	—	—	5
Comoros	—	—	—	—	66 (c)	66
Tahiti *a*	25	44	3	1	86 (d)	159
France *b*	9	—	8	8	45 (e)	—
TOTAL	513	54 (f)	23	23	199	812
PER CENT	(63)	(7)	(3)	(3)	(24)	(100)

Sources: Trade Returns of the Countries shown. Statistique D'Outre-Mer.

(a) Includes other French Oceania
(b) Re-exports, not included in export totals
(c) Exports mainly to France and Madagascar
(d) Includes 15 tons exported to Australia
(e) Includes 31 tons re-exported to other European countries
(f) Imports, less re-exports

(a) *Imports into the United States*

Imports of vanilla beans into the United States are distinguished both by their size and by their consistent volume over many years; imports of vanilla beans in 1959 amounted to 500 tons as in 1909. Thus, although accounting for more than 60 per cent of world trade, United States imports are now no larger than they have been over most of the past half-century.

United States imports of vanilla beans are taken mainly from Madagascar and Mexico, but small quantities are also taken from a number of other countries. Table II shows United States imports, 1954 to 1959.

TABLE II

Imports of vanilla beans into the United States, 1954-59 (*in tons*)

	1954	1955	1956	1957	1958	1959
Imports from:						
Madagascar	268	289	418	415	425	305
Mexico	96	94	81	97	87	130
Fr. Oceania	20	33	25	36	31	39
Indonesia	19	6	6	3	22	14
France	—	—	1	5	9	7
B. W. Indies	6	1	16	1	5	2
B. E. Africa	1	—	6	1	2	2
Seychelles	4	1	4	1	1	1
Others	2	3	5	23	1	2
TOTAL	416	427	562	582	583	502

Source: United States Foreign Trade Report 110

There is a small re-export trade, and most of the requirements of the Canadian and Japanese market are satisfied by imports from the United States. The bulk of the imports shown in Table II are, however, consumed domestically.

(b) *Imports into France*

For many years all the major producers of vanilla beans, with the exception of Mexico, have formed part of the French Union. For this reason France had until recently, not only a large domestic consumption of vanilla beans, but also a large entrepôt trade in this product.

Since 1950, however, the entrepôt trade has declined, partly owing to currency restrictions which have made it most profitable for producers to sell direct to consuming countries. Re-exports have fallen from some 500 tons in earlier years to the levels shown in Table III.

In spite of the decline in entrepôt trade France remains the largest market for vanilla beans after the United States.

TABLE III

Imports of vanilla beans into France, 1954-59 (*in tons*)

	1954	1955	1956	1957	1958	1959
Imports from:						
Madagascar	37	35	35	34	28	*a*
Fr. Oceania	27	33	44	39	49	*a*
Réunion	7	9	16	22	16	*a*
Others	3	2	2	—	2	*a*
TOTAL NET IMPORT	74	79	97	95	95	86
RE-EXPORT	136	83	65	52	45	*a*

Source: Commerce Exterieure *a* Not available

(c) *Imports into Western Germany*

Western Germany is now a major importer of vanilla beans, drawing the greater part of its supplies from Madagascar. Imports, which are shown in Table IV, have risen considerably in recent years. Since 1955 imports of vanilla beans into Western Germany have exceeded imports of vanilla beans into the United Kingdom both in quantity and value.

TABLE IV

Imports of vanilla beans into Western Germany, 1954-59 (*in tons*)

	1954	1955	1956	1957	1958	1959
Imports from:						
Madagascar	17	20	33	24	30	31
Fr. Oceania	1	2	1	2	3	6
Zanzibar	—	—	—	1	2	1
Others	—	—	1	1	1	1
TOTAL	18	22	35	28	36	39

Source: Der Aussenhandel

There are signs that Western Germany is now developing an entrepôt trade in vanilla beans. For many years re-exports have been of minor importance, but more recently Western Germany has become the largest single supplier of vanilla beans to the United Kingdom.

(*d*) *Imports into the United Kingdom*

About 25 to 30 tons of vanilla beans are imported into the United Kingdom each year, representing some 2 to 3 per cent of the total world trade in vanilla. The greater part of these imports is normally derived from other European countries, principally France and Germany. France was the largest single supplier before 1958, but imports from Western Germany have increased considerably in recent years, and both in 1958 and in 1959 the latter country was the largest single supplier to this market. Sizeable imports are also made from Réunion, while smaller quantities are imported from East Africa, principally Uganda, from the Seychelles and from French Oceania. Imports into the United Kingdom, 1954 to 1959, are show in Table V.

TABLE V

Imports of vanilla beans into the United Kingdom, 1954-59 (*in tons*)

	1954	1955	1956	1957	1958	1959
Imports from:						
W. Germany	—	—	—	3	12	8
France	23	10	10	10	6	8
Seychelles	—	—	3	2	4	3
Fr. Pacific	—	—	3	2	3	2
Réunion	8	4	9	6	4	2
Uganda	2	2	*a*	*a*	*a*	2
Other B. E. Africa	—	—	2	2	2	—
Others	2	3	—	—	—	—
TOTAL IMPORT	35	19	27	25	31	25
RE-EXPORT	1	1	2	1	3	*b*
NET IMPORT	34	18	25	24	28	*b*

Source: Annual Statement of the Trade of the United Kingdom

a Included with Other British East Africa

b Not available

It is not possible to discern any noteworthy trend in the quantity of vanilla beans imported into the United Kingdom. The quantity imported varies from year to year, but there are no signs that imports are tending either to increase or to decrease in the long term.

USES OF VANILLA

Vanilla flavourings are among the most commonly used flavouring materials. Vanilla flavour is 'standard' in many manufactured foodstuffs and there is also a large use for domestic culinary purposes. For this reason there is a considerable potential usage of natural vanilla, but the actual use of the natural material is much restricted by the competing

usage of artificial vanilla flavouring materials which are produced in large quantities and sold at very low prices. However, a synthetic product, i.e., vanillin, made from lignin, guaiacol and eugenol does not fully reproduce the true flavour of the vanilla bean and for this reason there is a continuing demand for the natural material.

The principal use of vanilla beans, or of the extract derived from the beans, is in the flavouring of ice cream. Vanilla is the most commonly used flavour and, in the United States, France and the United Kingdom, vanilla flavoured ice creams account for more than half the total output. Most vanilla flavoured ice cream is flavoured with synthetic materials, but natural vanilla flavouring is still used both alone and in special blends of natural and synthetic flavours. Although the natural product is responsible for only a small proportion of the total usage of vanilla flavours in ice cream, the ice cream industry remains the largest single user of natural vanilla.

Vanilla is also much used for domestic flavouring, but the extent to which natural vanilla is used varies from one country to another. In the United States and the United Kingdom natural vanilla is largely used in extract form and it is therefore difficult to determine the extent of its use; it is believed, however, that most vanilla flavours used domestically now consist largely or entirely of substitute materials. In France, on the other hand, it is estimated that about a half of the natural vanilla retained within the country is consumed domestically. The beans are purchased, as such, by French housewives to provide a ready source of the natural flavouring material. This practice is now virtually unknown in the United Kingdom and some five years ago the Secretary of the London Wholesale Spice and Rice Dealers' Association stated that there was little if any demand for vanilla pods in the grocery trade, and so far as he could ascertain none of his members dealt in this product.

Vanilla beans, or the extract derived from the beans, are also used in other foodstuffs for flavouring, particularly in chocolate, biscuits, and confectionery manufacture, and in the baking industry. Other uses are in perfumery, where the flavour is used as a conditioner for alcohol, and in various pharmaceuticals.

Substitutes

Vanillin is a readily available and widely used substitute for vanilla beans, selling at much lower prices than the natural material.

Recently, the production of vanillin from lignin has led to much lower prices and is gaining in importance at the expense of vanillin made from guaiacol or from eugenol derived from clove oil. Some users still prefer eugenol vanillin but, as it is twice as costly as lignin vanillin, its use is now understood to be declining.

Consumption of vanillin has risen steadily in the United States, which is the largest market for vanilla flavouring materials. Production rose from 110 tons in 1935 to 445 tons in 1951 and is now estimated at 670 tons annually. The significance of this production may be judged from the fact that any given quantity of vanillin is claimed to be equivalent in strength to the extract from 12 times that quantity of vanilla beans. On

this basis present United States consumption of vanillin would be equivalent to the use of some 7,000 tons of natural vanilla, as compared with about 500 tons of vanilla beans actually imported.

The chief incentives to the use of vanillin are its low, stable price compared with the relatively high and fluctuating price of beans, and the fact that, as a chemical product, its consistency of quality can be relied on. Prices in the United States, for instance, have remained almost constant over the last decade at $3·0 per lb. for lignin vanillin, while over the same period vanilla bean prices have ranged from $2·65 to $15·75 per lb. On account of the greater equivalent strength of vanillin the effective price difference is, of course, very much greater than these figures suggest. However, it may be that the other factors of price stability and consistent quality are as important.

There remains, however, a persistent demand for the vanilla bean and a market seems virtually assured to this product since no substitute material, as yet, has reproduced the full flavour of the vanilla bean. The latter derives not only from the vanillin contained in the beans, but also from other resins and compounds which are present in minute quantities. Reports from ice cream manufacturers in the United Kingdom indicate that no reduction in their present use of vanilla beans is envisaged and that the position is now relatively stationary with natural vanilla holding its own against competition from substitute products. It is indeed suggested that any appreciable reduction in the price of vanilla beans in the long term might result in some increase in the demand for natural vanilla.

Prices of Vanilla Beans

In the section on production it was shown that the supply of vanilla beans fluctuates widely while the demand remains relatively stable. In those circumstances prices inevitably fluctuate severely. Thus in the past five years the highest grades of Madagascar vanilla, as shown in Table VI, have ranged in price in the United Kingdom from 42s. to 96s. per lb., Tahiti vanilla from 32s. to 68s., Uganda vanilla of different qualities from 10s. to 94s., and Seychelles vanilla from 26s. to 98s. Over a slightly longer period even wider fluctuations have been experienced. A grade of Madagascar vanilla recently selling at 63s. per lb., duty paid, sold on the same terms for 27s. 6d. per lb. in 1952, and for 120s. per lb. in 1959 and early 1960.

Table VI shows prices of certain selected grades of vanilla beans in the United Kingdom, 1956-60. It should be noted that the Madagascar and Tahiti vanilla prices are averages based on the sales of two grades, and are not necessarily the highest individual prices recorded for vanilla from those sources.

Although most of the vanilla of commerce is derived from *Vanilla planifolia* Andrews, there are variations in quality according to the country of origin, variations which appear to be due largely to methods of harvesting and preparation. It is also the case that the larger producers, with a well-established trade, produce the vanilla that is most consistent in quality. Bourbon type vanilla, produced in Madagascar, Réunion and the Comoros, sets the level of prices, and prices for vanilla from areas such as

Uganda and the Seychelles do little more than follow and reflect the movements of the Bourbon market.

TABLE VI
Vanilla prices in the United Kingdom, 1956-60
(shillings per pound)

Years (Qtrs.)	Madagascar *a*	Tahiti *b*	Uganda *c*	Seychelles *c*
1956. 1	42–48	36	26–36	26–36
2	43–52	32–43	22–48	29–52
3	48–52	38–43	45–48	49–52
4	47–52	40–48	23–48	32–52
1957. 1	48–52	40–48	10–23	34–51
2	52–58	40–48	10–46	38–51
3	52–58	40–48	38–46	40–50
4	51–55	45–48	46–50	40–50
1958. 1	58–63	50–54	45–55	45–55
2	63–66	52–54	52–59	52–59
3	71–77	56–60	*d*	*d*
4	85–87 *e*	53–57	57–69	61–75
1959. 1	82–87 *e*	59–64 *e*	60–68	61–76
2	84–87 *e*	59–60 *e*	72–81 *d*	69–78 *f*
3	90	66–68	72–81 *d*	70–85 *d*
4	89–96	63–65	69–94	85–98
1960. 1	92–96 *d*	63–65	80–94	83–98
2	87–92	52–60	80–85	82–87
4	60–87 *d*	37–46 *d*	50–71	52–71
4 *g*	58–60 *d*	39–40 *d*	42–51	45–52

Information from trade sources

a Madagascar Bourbon (Firsts and Seconds) c.i.f.
b Tahiti (White and Yellow label—50 per cent each quality) c.i.f.
c Prices ex London warehouse, according to length and quality
d Nominal
e Duty paid, ex London warehouse
f Small quantity of old crop
g October-November only

Grading and Packing

Well-prepared vanilla beans should be long, fleshy, supple, very dark brown to black in colour, somewhat oily in appearance, strongly aromatic and free from scars and blemishes. Low quality beans are usually hard, dry, thin and brown or reddish-brown in colour. Split beans should be marketed separately and are regarded as somewhat inferior to whole beans of the same grade. The moisture content may be as high as 45 per cent in the top grades and as low as 15 per cent in the poorest grades.

Careful grading and bundling of vanilla beans is of considerable importance, particularly in times of low prices when competition is great and appearance counts heavily. Matters which would certainly repay careful attention are bundling, separating split from un-split beans, eliminating scars and attempting to produce a supple, fleshy, dark, rather reddish bean.

Grading standards and packing methods are determined primarily by the country of origin and are dealt with in detail in the Appendix.

Market Prospects

The future trend of the vanilla market will be very much dependent on developments in Madagascar. As mentioned above, due to a 'regeneration' policy for the industry, production is expected to reach the high level of at least 600 tons per year as from 1961. (The 1961 crop is in fact estimated at about 700 tons). If this production were thrown on the market it could obviously have a very depressing effect on prices. However, in October 1960, a scheme designed to instal the principle of orderly marketing into the Madagascar vanilla trade was introduced by the Government. Since then a licence must be obtained from the Vanilla Price Stabilization Board (Caisse dé Stablilisation des Prix des Vanilles) for each consignment of vanilla exported. If the prices quoted for exports are below a level considered desirable by the Board licences will not be granted. It is understood that for the season 1960-61 the intention was that prices should not fall below about U.S. $13 f.o.b. (net) per kilo, i.e., roughly 42s. per lb.

Owing to certain internal difficulties the scheme has not worked according to plan, and new arrangements have been made for the issuing of export licences which will, it is hoped, make the Board's control over exports more effective.

It is as yet too early to judge how far the Board will be successful in its attempts to set a floor price for Madagascar vanilla, partly because the scheme has not worked according to plan, but mainly because the Board is now concerned with the disposal of a relatively short crop. The real test of the Scheme's effectiveness will come in the early spring of 1962, when the greatly expanded production of 1961 should reach world markets.

Since Madagascar is by far the world's largest single producer of vanilla, a successful orderly marketing scheme for the Madagascar product could have a much needed stabilising influence on the international trade in vanilla. This would be an encouragement to users, and could benefit other producing areas. However, the history of commodity control schemes indicates that these are rarely successful when they involve only a single producing country, even although this is the major producer. Often all that it succeeds in doing is creating a situation which other producing countries can exploit to their own advantage by following a diametrically opposed policy, thus nullifying the effect of the control scheme.

It may be that the major factor in determining the success of the Madagascar scheme will be climatic conditions. As already stated, the influence of climatic conditions is one of the main reasons for the marked variations in the annual world supply of vanilla. In so far as the Madagascar control scheme results in a stockpile of vanilla in that country, she will be in a position to benefit from short crops, whether in Madagascar or other areas, but a series of bumper crops could exert great pressure on the scheme. It should also be kept in mind that the very considerable planned increase in Madagascar production has not taken place in response to a marked increase in demand, and that, moreover, the demand for vanilla is notably inelastic. Experience has shown that even a considerable reduction in price may not clear the market. Therefore if the control scheme should break down, and the total available supply of

vanilla be greatly increased, it is difficult to see how a serious, and possibly a catastrophic, fall in prices could be avoided.

It was stated above that the Madagascar control scheme, if it lent stability to the vanilla trade, might to that extent be of benefit to other vanilla producers. Against that, it should be pointed out that, whether or not the control scheme succeeds, the net effect of a sustained expanded production in Madagascar could well be disadvantageous to the small producers and the new producers, since Madagascar is a source of the most favoured type of vanilla, i.e., Bourbon, and has the long experience that promotes consistency in quality and good standards of grading and packing. It should also be kept in mind that Madagascar, as a member of the French Community, will benefit from the tariff concessions given by members of the Common Market to each other.

APPENDIX

Grading and Packing

Mexican Vanilla

Mexican beans are marketed in seven grades, ranging from beans of exceptional quality to the most inferior and 'cuts', moisture content varying from about 40 per cent down to about 20 per cent. 'Cuts' consist mainly of pods which have been damaged by mildew during the curing process, and the damaged parts cut away. They also include beans of inferior quality. Whole pods are sold either loose in bulk or made up into neat bundles of 50 to 90 each, tied at each end and in the middle; the bundles are packed into tin boxes containing up to 85 lb. The boxes are soldered and shipped in wooden cases each containing three boxes.

Bourbon Vanilla

Originally produced in the Island of Réunion, Bourbon vanilla now includes all the beans grown in Madagascar and the Comoros and Réunion is usually produced in five qualities—Extra, First, Second, Third and Fourth. Split beans are marketed separately in corresponding qualities. The beans are tied only in the middle, the bundles being packed in tins lined with greaseproof paper, containing 18 lb. to 22 lb. each. The tins are then packed in cases of six.

Tahiti Vanilla

Tahiti vanilla is prepared similarly to the Mexican. Tahiti vanilla is characterized by end-ties only. It is marketed in six grades, distinguished by labels of different colours. The first four grades consist of sound unsplit beans of varying length, the fifth grade includes beans of all lengths, and split or scarred beans, whilst the sixth (most inferior) grade consists of damaged beans. The bundles are packed in tins of about 90 lb., one tin to a case.

Java Vanilla

Java vanilla is classified into 'Prime', both whole and split, 'Red', also whole and split, and 'Second Quality'.

Book Reviews

REPORT ON AN ECONOMIC STUDY OF SMALL FARMING IN JAMAICA, by David Edwards. 370 pp., 6¼ × 9½. (Jamaica: Institute of Social and Economic Research, University College of the West Indies.) Price 28*s*.

This book is derived from a Ph. D. thesis, which one is glad to see has been accepted, as it is an admirable study of the small farm in Jamaica. Admittedly the examination is not very up to date; it was made in 1954-55, but the author explains that events since 1955 have confirmed the major implications of the enquiry.

The purpose of the study was to secure an understanding of the economic aspects of small-farming systems. Though the sample was by no means a statistical one, it can be seen that Dr. Edwards had a great insight into all the complex ancillary factors that beset the small farmer and a feeling for their difficulties. Thus, though we find all the familiar *longeurs* and glimpses of the obvious of such studies ('The goals of the large farmer are very different from those of the small farmer'), perhaps these are inevitable: at any rate it is compensated for by the very good overall picture produced.

The background is that population pressure is high (350 persons per square mile) and the present level (or rather the level in 1953-54), 1½ millions, increases at the rate of 2½ per cent per annum. Two-thirds of the population live on farms and just under half of the gainfully occupied population work on them. However, one suspects that, but for a handful of the wealthy, those who live on farms also work on them, for a small farm has but little room for idle hands, especially with the complex tropical crops. The per capita national income is £78: though this compares favourably with, say, Tanganyika, £18, it is not much when put alongside the figures for the United Kingdom, £275, and the U.S.A. £670.

The chapter on Income and Level of Living is particularly interesting. It seems that in spite of deficiencies of diet, health was on the whole good but that the economic position of the small farmer was so precarious that ill health was much feared. He could be ruined by a spell of illness. As a consequence the farmer is prepared to spend money on remedies both magical and medical, the former being the more expensive at times. Unfortunately Dr. Edwards does not tell us which were the more effective.

Dr. Edwards has an admirable summary of the measures needed to secure improvement. The main thing seems to be to create such conditions that the farmer can clearly see that improvement is possible, to see that, from the Pandora's box of troubles that beset him, hope is also there.

G.O.

PRINCIPLES OF NEMATOLOGY, by G. Thorne. xiv+553 pp., 9¼ × 6¼. (New York and London: McGraw-Hill Publishing Co. Ltd., 1961.) Price £5 16*s*. 6*d*.

There is no doubt that this book, written by an acknowledged authority in the field, will meet a need of long standing. However, at the price it is unlikely to have found its way into many nematologists' Christmas stockings. Perhaps this is as well if the prospective recipient's main interest is in animal parasites; the book in fact deals solely with plant nematodes. As a guidebook to the identification of plant-parasitic nematodes it will provide a worthy successor to Goodey's classic treatise of 1933.

There are three introductory chapters on general aspects such as the role of nematodes in agriculture, a brief survey of control measures, useful notes on the collection and mounting of specimens, and a summary of nematode morphology. The remaining 14 chapters deal with taxonomy, and this is the section

that should prove invaluable to the worker in the field. The keys for identification are not very detailed, but are succinct and helpful. The author himself advises skipping through the illustrations once the higher taxonomic groupings have been estabiished, knowing the absurdities that result from the too slavish following of a key.

The descriptions of individual species are complete, including all the important tropical pathogens, and are accompanied by drawings of a very high standard, which illustrate five or six of the most important taxonomic characters as well as the whole worm. A useful feature is the inclusion of about 100 free-living forms which might be mistaken for parasitic species.

For each species there is an account of biology and distribution, and, for important parasites, sections on control and on the symptoms of the plant disease caused. The latter are in many cases shown by photographs. The reviewer feels that maps of distribution would in some cases have been extremely useful, particularly in the light of work on the temperature dependence of stages in the life cycle of such important plant parasites as the sugar beet eelworm and the citrus nematode.

There is an extensive bibliography and the book should prove to be a valuable practical guide for the field worker, be he plant pathologist, or agronomist. For the research nematologist the book will not be found to provide a complete review of the principles of the subject, and some aspects in which research is active are not mentioned, such as physiology or modes of locomotion.

R.M.

ANNUAL REVIEW OF PLANT PHYSIOLOGY. Volume 12. Edited by L. Machlis and W. R. Briggs. 502 pp., 6¼ × 9. (Annual Reviews Inc., Palo Alto, California, 1961.) Price $7.50.

The new volume of this annual review is again welcome for the high standard it maintains and the still wider field covered than in former years. Volume 11 contained nine main sections and the current edition has eleven; the two extra subjects are amino acid synthesis and stress physiology. The first is dealt with by A. I. Virtanen of Helsinki who very ably follows the history of work in this field, leading to the inevitable conclusion that 'the whole problem urgently needs further elucidation'.

The section on cell structure and function is dealt with in two papers, by F. L. Crane, and by G. Setterfield and S. T. Bayley. The former paper studies the role of mitochrondria and now they have been isolated concludes that we are in the era of 'mitochondrial chemistry', so with the molecules identified in due course we shall find out how they function and why they are influenced by external agents.

Mineral nutrition is well covered and an important paper by Dr. D. J. D. Nicholas (of Long Ashton Research Station, Bristol) shows the part minor chemists play in membrane structures. Further investigation in this field, says Dr. Nicholas, cannot be done by present day biochemical, or biophysical methods but must await the discovery of an *in vivo* technique of cell study.

Dr. G. Webster explains his work on protein synthesis in plants and shows that a picture is emerging of the chemical steps involved, which soon should become much clearer.

The important subject of photosynthesis is covered by two papers (J. F. Talling; G. Hoch and B. Kok). Talling studies photosynthesis under natural conditions and Hoch and Kok give a selected history of the uncovering of the process. It is of great value for it can bring even the non-technician up to date on this phenomenon.

The next three sections are on respiration, general metabolism and water relationships. The biochemistry of renascence (J. E. Varner) was particularly interesting to this reviewer, as was also that on water deficits (Y. Vaadia, F. C. Raney and R. M. Hagan). In this last paper the important practical point is made that plant growth does not depend directly on soil moisture supply, but on the balance between transpired and absorbed water, (a point which,

when one comes to think of it, all farmers know instinctively.) However, the main thing is that prediction of water deficit cannot be made from soil moisture alone or transpirations data alone.

The papers are well presented and documented. The editor allows each author to choose his method of presenting his bibliography, some being alphabetical and some in sequence as they arise in the text: one cannot help feeling that the former is a better system.

G.O.

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Compiled by MISS V. CLARKE

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